

CHAPTER 3

SPECIES OF GREATEST CONSERVATION NEED AND PRIORITY HABITATS

3.1. Species Occurrence Records and the GCN Species List Review

A FUNDAMENTAL COMPONENT of developing conservation priorities is documenting current distributions of species and their habitats across the state, in particular, the designation of species of Greatest Conservation Need or "GCN species."

3.1.1. Updates to Species Occurrence Data in the SWAP Relational Database

During the creation of the first SWAP in 2005, the GIS relational database was designed to allow for continuous updates to species occurrence data gathered from a wide variety of data sources (TWRA 2005, p. 45). The Nature Conservancy has worked alongside the Tennessee Wildlife Resources Agency (TWRA) and other partners, including the Tennessee Department of Environment and Conservation (TDEC) Division of Natural Areas and the Tennessee Valley Authority (TVA) Heritage Program, to continually add to the datasets on known species distributions across the state.

Consistent data collection and assimilation work during the last decade has increased the number of species occurrence records available for use in the SWAP revision effort. Table 1 compares the differences in occurrence records available for planning in 2005 and 2015. In 2005, the database included approximately 25,000 aquatic, terrestrial and subterranean animal records, which has now been expanded to over 316,000 records. The records include an increase in the number of observations from cave

Photo credits: Conasauga Blue Burrower - Carl Williams, TWRA; Golden Eagle - Tony Hisgett; Gray Tree Frog - Dave Huth

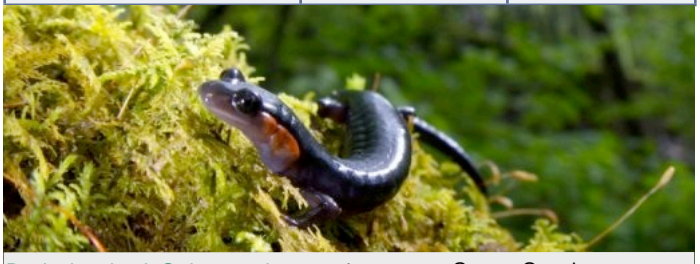
systems, with data from 300 more caves in 2015. An occurrence dataset of approximately 131,000 records for fish species known to be reproductive hosts for freshwater mussels was consolidated and added. Datasets of observational records for bird species have been improved, and the database now includes over 140,000 bird occurrences.

The increase in occurrence data for planning purposes in 2015 is attributable to three major opportunities: (1) better access to information housed in different data management systems, particularly **eBird** and TWRA's Aquatic Database System (TADS); (2) increase in occurrence records compiled in TDEC Division of Natural Areas and TVA Natural Heritage databases; and (3) increased levels of GCN species survey efforts and documentation conducted by TWRA and conservation partners. Table 2 provides a summary of the occurrence records now available for planning related to TWRA's improvements to data management and focused survey efforts, including over 2,700 records collected in the field by the nongame inventory program.

Finally, between 2005 and 2015, The Nature Conservancy worked with TDEC Natural Heritage program staff to add 568 plant species to the overall dataset. The addition of almost 10,000 plant species records increased the overall occurrence dataset available from 316,000 to approximately 326,000 records (Table 1). This collaborative effort allows for plant occurrence records to be utilized in a variety of ways including plant species-specific conservation planning, improved habitat distribution mapping of rare plant community types, and more comprehensive mapping of habitat priorities for plant and animal species combined. The availability of this data also provided the 2015 SWAP team with the option of identifying plants as GCNs if desired.

Table 1. **Comparison of species occurrence records available for planning in 2005 and in the 2015 revision process**

GCN group	2005	2015
Aquatic	5,268	149,224
Subterranean	961	7,000
Terrestrial	19,396	160,166
Plants	Not included	9,779
Total	**25,625**	**326,169**



Red-cheeked Salamander, endemic to Great Smoky Mountains National Park - Jeffrey Basinger, Freshwaters Illustrated

Table 2. **Summary of 2015 occurrence record availability from TWRA data management efforts and field surveys**

GCN group	Number of Occurrences (2015)
Aquatic	2,117
Subterranean	68
Terrestrial	16,566
Total	**18,751**

Large-leaved Grass-of-parnassus - "Eleanor"

3.1.2. Updates to the Species of Greatest Conservation Need List

The first major phase of the 2015 update focused on the review of the species of greatest conservation need (GCN) list. This process involved examining the 2005 GCN definition criteria; ensuring all species taxonomic names, conservation ranks, and legal designations are current; reviewing the full 2005 GCN species list by faunal group; and engagement with taxonomic field experts to ascertain that 2015 GCN selections align with current understandings of population status and the GCN definition criteria.

The core planning team determined that the overall GCN definition and selection rationale from 2005 was appropriate for the 2015 revision (TWRA 2005, p. 34). The three main elements include the species' global and state conservation status rankings, state and federal legal status designation, and additional rankings based on general population or habitat condition trends. Box 1 summarizes the definitions of global and state conservation ranks and Box 2 outlines the rationale for the selection of an individual species as a GCN in Tennessee.

Box 1. TDEC Natural Heritage Program global and state ranking system for species

Global Ranks:

G1 = critically imperiled globally; 5 or fewer occurrences worldwide imperiled globally

G2 = imperiled globally; 6 to 20 occurrences worldwide

G3 = very rare or restricted throughout range; 21 to 100 occurrences worldwide

G4 = apparently secure globally though locally rare sometimes; 100 to 1000 occurrences worldwide

G5 = demonstrably secure globally; over 1000 occurrences worldwide

G? = uncertain global rank

GH = historic global occurrence; possibly extinct

GNR = not ranked currently at global level

G#Q = questionable taxonomy

G#G# = mixed rank due to uncertainty

G#T# = rank of a subspecies or variety

State Ranks:

S1 = critically imperiled in state; 5 or fewer occurrences statewide

S2 = imperiled within state; 6 to 20 occurrences statewide

S3 = rare and uncommon in state; 21 to 100 occurrences statewide

S4 = apparently secure globally though locally rare sometimes; 100 to 1000 occurrences statewide

S5 = demonstrably widespread and secure in the state

S? = uncertain state rank

SH = historical occurrence in state

SNR = not ranked currently at state level

SP = potentially occurs in state

SR = reported to occur in state

SX = believed extirpated from state

S#S# = mixed rank due to uncertainty

(Note: additional global and state ranks are listed in this document, for more complete definitions please refer to the TN Division of Natural Areas' website at: **https://www.tn.gov/environment/section/natural-areas***)*

Beginning in October 2013 the planning team consulted taxonomic and field experts in mammals, birds, reptiles, amphibians, fish, mollusks, crustaceans, insects, and plants to finalize the updated 2015 GCN list. In November 2013, a species expert workshop was held to educate these experts about the 2015 update process and gather their feedback on GCN definition criteria, taxonomic accuracy, and choice of species for GCN designation. The planning team continued the consultation process through January 2014 to discuss the process with experts unable to attend the workshop and finalize choices.

Between 2005 and 2015, over 300,000 species occurrences were added to Tennessee's SWAP database, improving designation of GCN species and their priority habitats.

Box 2. Summary of rationales for selection and non-selection of GCN species

Rationale Categories for Selection as GCN Species

1. Globally rare, imperiled, or endangered species (G1-G3 NatureServe rank) or federal status category of LE (Listed Endangered), E/SA (Endangered by Similarity of Appearance), LT (Listed Threatened), T/SA (Threatened by Similarity of Appearance, PE (Proposed Endangered), PT (Proposed Threatened), or C (Candidate species); or state status category of E (Endangered), T (Threatened), or D (Deemed In Need of Management).
2. Special concern species due to declining trends, or otherwise vulnerable due to endemic, limited, disjunct, or peripheral status in region.
3. Special consideration wide-ranging species due to:
   a. **Partners in Flight** (PIF) score of 22 or higher
   b. National Shorebird Prioritization Score of 4 or higher
   c. National Wind Coordinating Collaborative category of 'High'
   d. Being a "keystone" species within a biodiversity "hotspot" or part of a globally significant aggregation of species
   e. Species is strongly dependent upon ecological processes often interrupted across the landscape.

Rationale Categories for Non-selection as GCN Species

1. Species occurs in the state but is not significantly imperiled, endangered, declining, or of special management concern.
2. Species range and/or habitat does not sufficiently occur in state to warrant target status.
3. Species is of uncertain taxonomic status.
4. Species is believed to be extinct range-wide.
5. Actively managed game species with sufficient number of viable populations in state.
6. Species is of historic significance but cannot currently be restored in the state.
7. Species distribution in habitats in state is either unknown or too uncertain to warrant target status.

Green Anole, example of a common, non-GCN species - Hunter Desportes

Plants as GCN species

Participants in the SWAP Species Experts Workshop held November 2013 to assist in updating the Species of Greatest Conservation Need List - Chris Simpson, TWRA

In consultation with scientific experts, the core planning team made the determination to grant 568 plant species GCN status in 2015. Plant species were not assigned GCN status during the 2005 planning effort. The decision to assign plants GCN status is consistent with the AFWA 2012 Best Practices Guidance, the recommendations of a NatureServe review of the role of plants in State Wildlife Action Plans (Stein and Gravuer 2008), as well as **the choice of 16 other states** which either selected plants as GCNs in 2005 or have added them since that time. States have chosen to add plants for a variety of reasons including a desire to help prevent federal listings of a greater spectrum of species, to collaborate with additional partners whose focus is on plant conservation, to garner additional funding for overall conservation efforts, and to help ensure that their SWAP is as comprehensive a conservation blueprint as possible for their states. (AFWA 2012).


GCN plant species clockwise from top left: Purple Milkweed - Katja Schulz; American Chestnut - Nicholas A. Tonelli; Clinton's Lily - Superior National Forest; Pink Lady's-slipper - Liz West

In addition, wild flora share many of the same management issues as wild fauna. Many of the same factors causing broad declines in the nation's wild animals – habitat destruction

or alteration, spread of invasive alien species, emergence of lethal diseases, and increasingly, shifts in climate – all are taking a toll on the nation's plant life. Because many rare plants are highly localized, growing only in very specific soils or micro-climates, they are particularly susceptible to local habitat disturbances and direct damage to individuals and populations.

Of Tennessee's 2,395 plant species, 6.3% are at risk, making Tennessee the 19th-ranked state for plant species at risk. Without focused conservation attention to the growing plight of plant species, Tennessee could lose significant portions of its wild heritage and the ecological resilience that comes with that diversity (Stein and Gravuer 2008).

Tier Status

The Congressional mandate to states regarding the creation of State Wildlife Action Plans is to invest in conservation activities that assist in the prevention of future federal listings (e.g. Federally Endangered or Federally Threatened). Different state agencies also maintain separate jurisdictional authorities over species and habitat management. For these reasons, the 2005 SWAP designated "tiers" to track the legal status and jurisdictional authorities associated with all GCN species (TWRA 2005, p. 43). The 2015 core planning team decided to maintain the original tier designation system and add a fourth tier for plants. Box 3 summarizes the definitions of each tier designation.

Including the tier status in the SWAP relational database/ GIS system allows planners to efficiently determine which species may be appropriate for different types of

Box 3. Summary of tier designations for GCN species

Tier 1: Species defined as wildlife under Tennessee Code Annotated 70-8-101, (i.e., amphibians, birds, fish, mammals, reptiles, crustaceans & mollusks), excluding federally listed and game species

Tier 2: All other fauna not defined as wildlife under Tennessee law (i.e., insects and other invertebrates)

Tier 3: Federally listed or game species which have alternative conservation funding

Tier 4: Plant species of Greatest Conservation Need

Examples of Tier 1-4 species, clockwise from top left: Tier 1: Mud Salamander - Chris Simpson, TWRA; Tier 2: Diana Fritillary - Pondhawk; Tier 3: Pallid Sturgeon (with children) - Scott Mensing, U.S. Army Corps of Engineers; Tier 4: Canada Anemone (*Anemone canadensis*) - Superior National Forest

conservation project funding and which species are covered by various regulatory and management jurisdictions. TWRA does not have legal responsibility for rare plant species conservation, but wishes to track and incorporate the management needs of plants whenever feasible in ongoing conservation activities, particularly with respect to habitat protection and restoration for a broad suite of species.

The 2005 SWAP identified 664 aquatic, terrestrial, and subterranean GCN species in Tennessee. With the addition of plants as Tier 4 GCNs and the changes made to selections in other species groups, the number of GCNs for Tennessee in 2015 is now 1,499. Table 3 summarizes the changes made to the GCN list between 2005 and 2015. Appendix C provides the full updated list of 2015 GCN species including information on their state and global conservation ranking status, state and federal legal status, and tier designation.

Table 3. Comparison of GCN species designations between 2005 and 2015

	Number of GCN Species	
	2005	2015
Aquatic	246	276
Subterranean	185	411
Terrestrial	233	244
Plants	0	568
Total	664	1,499

GCN species clockwise from upper left: Aquatic: Chickamauga Crayfish - Carl Williams; Subterranean: Virginia Big-eared Bat - USFWS; Terrestrial: Red Squirrel - Giles Gonthier; Plant: Wood Lily - Jay Sturner

3.2. A Strategic Focus on Habitat Conservation

Habitat Prioritization Process Summary

In summary, the 2015 process for prioritizing habitats according to their importance for GCN species included the following steps:

1. **Terrestrial Habitat Mapping:** Utilize the most recent Southeast Gap Analysis Project's (SEGAP) landcover mapping (2001), which includes NatureServe's ecological system classification framework, to map habitat types for GCN species.
2. **Updates to mapping units:** Revise both terrestrial and aquatic mapping units to provide units of analysis that are more consistent statewide as well as smaller and more refined, allowing for even aggregation and disaggregation of data outputs when determining priorities, performing subsequent analyses on problems affecting habitats, and goal setting.
3. **Modeling and prioritizing habitat used by species:** As in 2005, this process combines 3 steps to develop overall habitat priority designations: identifying habitats preferred by each species, rating GCN species priority, and modeling actual habitat occupancy on the basis of species data records.
    - Assign habitat preferences for all terrestrial GCN species to NatureServe ecological systems (adding newly designated GCN species including GCN plants) on the basis of expert opinion. All terrestrial GCN plant and animal species now have habitat preference ratings for every natural ecological system in the GIS database.
    - Develop scores rating the priority of GCN species using data indicating how recently species were recorded in each location, combined with species rarity designations. Scores are designed to capture the species' rarity, likely persistence at or near a specific location, and the quality of the population when that information is available.
    - Use individual species occurrence observations as the beginning point for mapping habitat occupancy, then combine this with information that recognizes inherent differences in species' dispersal (movement) abilities to calculate a species habitat "footprint."
4. **Generating priority habitat maps**: Finally, combine the GCN prioritization scores with the species distribution footprints using the appropriate, updated mapping units and for terrestrial species, their habitat preference scores. Calculate ranks of low, medium, high, and very high priority habitats separately for each major type (terrestrial, aquatic, and subterranean) in each region of the state because some regions have higher concentrations of imperiled species. Compared to a single scoring standard, this method more fully captures all habitat priorities statewide.

The following discussion gives a high level overview of the major improvements to spatial datasets and habitat prioritization scoring methodologies employed during the 2015 update. These changes, combined with the significant addition of species records to the database, have improved the resolution of the data and

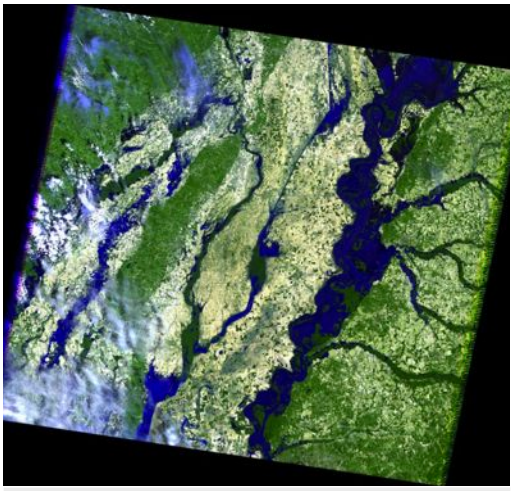
Improvements to 2015 spatial datasets and prioritization methods have increased both resolution of the data and flexibility of analyses possible at different spatial scales.

created the opportunity for more flexible applications of the outputs for use in a greater variety of subsequent analyses, decision-making contexts, and collaborations at different spatial scales. The Nature Conservancy (TNC) developed a companion GIS revision report to this 2015 SWAP to provide detailed information on all spatial data, methods, and formulas used to identify GCN species habitat priorities (Wisby and Palmer 2015).

3.2.1. Standardized Habitat Classification

The 2005 SWAP effort provided a major advance in statewide conservation planning through the intentional use of standardized habitat classification units and linking GCN species habitat preferences to those habitats. The emphasis on habitat classification and mapping improved the ability of conservation partners to make collaborative investments in habitat restoration and protection in all regions of the state. This success encouraged TWRA to adopt the same terrestrial habitat classification approach in the agency's 2014-2020 Strategic Plan (TWRA 2014).

In its 2014-2020 Strategic Plan, TWRA emphasizes the importance of a habitat-based approach to management, since habitat is the cornerstone of providing healthy populations of animals. "Provided that public and private lands and waters can provide ample quality habitat, species should be self-supporting if given the proper protection" (TWRA 2014). **The Strategic Plan** is now organized around broad habitat types generally corresponding to those used in the 2005 SWAP: Grassland, Forestland, Wetland, Karst, Streams and Rivers (TWRA 2014). The Strategic Plan also includes reservoir impoundments and urban areas as important wildlife management areas for fisheries and other habitat values.



Landsat 5 image, Flooding along the Mississippi (TN, AR, KY, MO) May 10, 2011

The 2015 SWAP update uses the same basic terrestrial habitat classification scheme developed in 2005. In the 2005 SWAP, the team used the Tennessee Gap Analysis Project's (SEGAP) landcover mapping, derived from 1990-1993 Landsat Thematic Mapper satellite imagery, as the base map of vegetation types and cross-walked the land cover classes to NatureServe's ecological systems (TWRA 2005, p. 61). The NatureServe ecological systems then served as the habitat types for terrestrial species. The 2015 update uses more recent 2001 SEGAP landcover mapping, which uses the NatureServe ecological systems as its classification framework. The NatureServe ecological systems are again used as the terrestrial habitat types.

The 2001 SEGAP land cover classification remains the most comprehensive map of vegetation cover by ecological systems for the state. Appendix D provides a summary of the SWAP habitat classification hierarchy, including information on the distribution of habitat types by ecoregion.

For freshwater systems, the planning team made no changes to the ecological drainage unit and stream classification system adopted in 2005 (Smith et al. 2002). The U.S. Fish and Wildlife Service's Appalachian Landscape Conservation Cooperative is developing an updated classification scheme for rivers and

streams that was not yet available during the current planning horizon. In addition, a general physiographic scheme was used to classify karst systems (TWRA 2005, p. 8).

3.2.2. GCN Species Habitat Preferences

Following the selection of the habitat classification systems, the 2005 team used a process of expert-derived habitat preference assignments for terrestrial GCN species (TWRA 2005, p. 65). For every natural ecological system within each separate ecoregion, the planning team assigned a habitat preference rating for each species of "preferred," "suitable," "marginal," or "unsuitable."

The preference ratings are intended to categorize the relative utility of one ecological system type as habitat over another for each terrestrial species. For aquatic species, the occurrence record locations for GCNs were intersected in the SWAP GIS relational database with the freshwater classification designation of stream types, and these assignments were reviewed by the planning team (TWRA 2005, p. 65). No expert-derived preference assignments were made for subterranean species in 2005 due to lack of a consistent habitat classification for karst systems.

After completing the revision of the GCN species list, the 2015 planning team used the same process for assigning habitat preferences to all newly-designated terrestrial and freshwater GCNs. An interim project by TWRA, TNC, and Tennessee Department of Environment and Conservation (TDEC) Division of Natural Areas staff between 2005 and the 2015 comprehensive update process assigned karst preference ratings of trogloxene, troglophile, or troglobite (increasing degrees of dependence on cave environments) to all subterranean species based on their biological needs. These karst preference assignments were also maintained by the 2015 planning team.

The 2005 planning effort did not incorporate plant species, as no plants were designated GCN. However, during a project completed in 2009, TDEC Division of Natural Areas plant experts worked with TNC to make similar terrestrial habitat assignments for all plant species now included in the SWAP database. All terrestrial GCN plant and animal species now have habitat preference ratings for every natural ecological system in the 2001 SEGAP data. Appendix D provides an extensive summary of all 2015 GCN species and their habitat type preferences by ecoregion.

Top to bottom: Trogloxene: Northern Long-eared Bat - John Lamb; Troglophile: Cave Salamander - Dustin Thames; Troglobite: Tennessee Cave Salamander - Matthew Niemiller

In subsequent phases of priority habitat mapping in 2005 and 2015, aquatic habitat mapping did not use

the preference assignments in the database. This choice was made due to the complexity of mapping the range of different aquatic system stream types in conjunction with the expert-derived preference assignments.

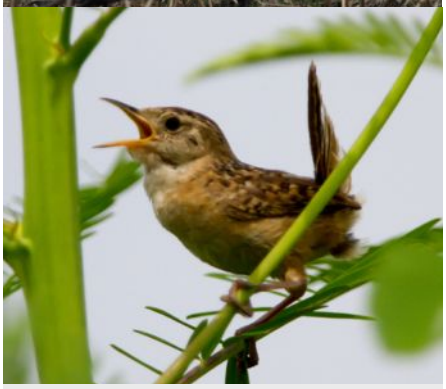
For use in the GIS mapping, the planning team assigned weights to terrestrial habitat preference ratings. In the 2005 model, these values were 10 points for preferred, 7 points for suitable and 3 points for marginal habitat designations. In the 2015 iteration, in order to emphasize the footprint of preferred habitats in the final mapping schemes, the ratings used are 10 points for preferred, 5 points for suitable, and 2 points for marginal habitats (Wisby and Palmer 2015). Finally, the 2015 model uses the karst preference ratings for each subterranean species as a scoring mechanism to capture the reliance of those species on karst habitats.

3.2.3. GCN Species Prioritization Scoring

In 2005 the planning team developed a prioritization scoring formula for GCN species using a combination of species rarity information and the presumed viability of a given species population (TWRA 2005, p. 80). The 2015 species prioritization scoring formula has been modified in two ways: (1) to reduce the complexity from the 2005 methods attempting to estimate population viability as a scoring component; and (2) to include federal and state legal listing status.

Specifically, as a substitute for a population viability rating estimate, the prioritization formula now uses a scaled point score associated with the date of last observation for every species occurrence (i.e., observation) record and the **NatureServe Element Occurrence Ranking score**, when available. In the scaled scoring system, occurrences with more recent observation dates are given more points, with the points tapering down for older records and records without dates receiving a nominal score of 20 out of 100 points. These two scoring elements represent the likelihood of a species' current persistence at or near the observation point and the quality of the population. The rarity portion of the species priority score, originally restricted to Global and State ranks (see Box 1, p. 26), has been amended to include federal and state legal listing status to account for potentially declining population trends triggering a legal status assignment (Tables 4 and 5). These trends may not be reflected in the Global or State rarity ranks alone (Wisby and Palmer 2015).

Species priority ratings of karst species and their occurrences are based only on NatureServe G-Ranks, when available, and on estimates of probable G-Rank designation for species not in the NatureServe database. These choices for



Top: Whooping Crane (G1 species) - Cynthia Routledge; Sedge Wren (G5 species) - Chris Sloan

Table 4. Federal species listing designations

Abbreviation	Designation	Explanation
LE	Listed Endangered	Taxon is threatened by extinction throughout all or a significant portion of its range
SAE	Endangered by Similarity of Appearance	Taxon is treated as an endangered species because it may not be easily distinguished from a listed species
LT	Listed Threatened	Taxon is likely to become an endangered species in the foreseeable future
SAT	Threatened by Similarity of Appearance	Taxon is treated as a threatened species because it may not be easily distinguished from a listed species
PE	Proposed Endangered	Taxon proposed for listing as endangered
PT	Proposed Threatened	Taxon proposed for listing as threatened
C	Candidate species***	Taxon for which the USFWS has sufficient information to support proposals to list the species as threatened or endangered, and for which the Service anticipates a listing proposal
(status, XN)	Nonessential experimental population in portion of range	Taxon which has been introduced or re-introduced in an area from which it has been extirpated, and for which certain provisions of the Act may not apply
PXN	Proposed nonessential experimental population	

*** Taxa listed as candidate species may be added to the list of Endangered and Threatened species, and as such, consideration should be given to them in environmental planning. Taxa listed as LE, LT, PE, and PT must be given consideration in environmental planning involving federal funds, lands, or permits, and should be given consideration in all non-federal activities.

Table 5. State species listing designations

Abbreviation	Designation	Explanation
E	Endangered	Any species or subspecies whose prospects of survival or recruitment within the state are in jeopardy or are likely to become so within the foreseeable future
T	Threatened	Any species or subspecies that is likely to become an endangered species within the foreseeable future
D	Deemed in Need of Management	Any species or subspecies of nongame wildlife which the executive director of the TWRA believes should be investigated in order to develop information relating to populations, distribution, habitat needs, limiting factors, and other biological and ecological data to determine management measures necessary for their continued ability to sustain themselves successfully. This category is analogous to "Special Concern."
S	Special Concern	Any species or subspecies of plant that is uncommon in Tennessee, or has unique or highly specific habitat requirements or scientific value and therefore requires careful monitoring of its status.

Table 5. State species listing designations, additional modifiers for plants

Abbreviation	Designation	Explanation
PE	Proposed Endangered	Any species or subspecies of plant nominated by the Scientific Advisory Committee to be added to the list of Tennessee's endangered species. After approval by the commissioner of the Dept. of Environment & Conservation and the concurrence of the commissioner of Agriculture, these plants will formally become State endangered.
PT	Proposed Threatened	Any species or subspecies of a plant nominated by the Scientific Advisory Committee to be added to the list of Tennessee threatened species. After a public hearing, these plants will formally become State threatened.
E-PT	Endangered-Proposed Threatened	Species which are currently on the state list of endangered plants, but are proposed by the Scientific Advisory Committee to be down- listed to threatened. After approval by the commissioner of the Dept. of Environment & Conservation and the concurrence of the commissioner of Agriculture, these plants will formally become State threatened.
E-PS	Endangered-Proposed Special Concern	Species which are currently on the state list of endangered plants, but are proposed by the Scientific Advisory Committee to be down- listed to special concern. After approval by the commissioner of the Dept. of Environment & Conservation and the concurrence of the commissioner of Agriculture, these plants will formally become State special concern.
T-PE	Threatened-Proposed Endangered	Species which are currently on the state list of threatened plants, but are proposed by the Scientific Advisory Committee to be listed on the state endangered list. After approval by the commissioner of the Dept. of Environment & Conservation and the concurrence of the commissioner of Agriculture, these plants will formally become State endangered.
T-PS	Threatened-Proposed Special Concern	Species which are currently on the state list of threatened plants, but are proposed by the Scientific Advisory Committee to be down- listed to special concern. After a public hearing, these plants will formally become State special concern.
P	Possibly Extirpated	Species or subspecies that have not been seen in Tennessee for the past 20 years. May no longer occur in Tennessee.
C	Commercially Exploited	Due to large numbers being taken from the wild and propagation or cultivation insufficient to meet market demand. These plants are of long-term conservation concern, but the Division of Natural Heritage does not recommend they be included in the normal environmental review process.

karst species ratings were made because knowledge of karst biodiversity, while improving, still remains limited and many species have not been assessed for Global or State rarity ranking or State and Federal legal status.

3.2.4. 2015 Updates to Habitat Mapping Units

Terrestrial Habitats

The 2005 habitat mapping effort used products from the U.S. Census Topologically Integrated Geographic Encoding and Referencing (TIGER) database of roads to segment Tennessee's terrestrial landscape into roadless block sections. These roadless block areas were used as the smaller grain-sized land unit basis to assess priorities. For the 2015 update, the roadless block units have been replaced by uniform 100-acre hexagons statewide, subsequently grouped into 700-acre rosettes for terrestrial habitat prioritization. The full land area of Tennessee contains approximately 40,000 700-acre rosette clusters.

The 100-acre hexagon framework was also used to link cave sites (subterranean habitat) to the surrounding terrestrial landscapes in which they are located for further assessment (Table 6).

Woodland at Catoosa WMA - Clarence Coffey, TWRA (retired)

Roadless block areas vary in size and shape and have an inconsistent footprint on the landscape. The standardized, regular hexagon grain size approach is preferable for organizing prioritization assessments because it is consistent statewide and allows for even aggregation and disaggregation of data outputs when determining priorities. Also, the hexagon approach is not related to or dependent upon political or management jurisdictional boundaries, and instead can be used to examine data in a flexible manner within the context of these other boundaries when needed (Nhancale and Smith 2011).

Aquatic habitats

The 2005 version of the SWAP aquatic datasets used 12-digit hydrologic units (HUC12) as the units of analysis. Since its initial development, the aquatic component of the database has also been extensively revised and refined by TNC. The 2015 SWAP update uses this new hydrological modeling framework developed by TNC in a Microsoft Access platform using the National Hydrography Plus (NHDPlus v2) datasets from the U.S. Geological Survey and the U.S. Environmental Protection Agency (Table 6).

Built upon the 1:100,000-scale National Hydrography Dataset and 1:24,000-scale digital elevation models (DEM), NHDPlus v2 defines the catchment areas draining into each individual stream segment in a hydrologic

Estill Fork at Bear Hollow Mountain WMA, third order stream - Josh Campbell, TWRA

network. The NHDPlus v2 dataset also defines the hydrologic upstream and downstream connections between individual stream segments, as well as providing a number of other relevant attributes, such as mean annual flow velocities and volumes. Dam locations and GIS attributions from the National Inventory of Dams (NID) dataset were also incorporated. Dams determined to be on the stream network were linked to their corresponding NHDPlus v2 stream segments for incorporation into the model. Normal storage values from NID data, as well as NHDPlus v2 flow volumes at linked stream segments, were used to estimate mean annual residence time of water behind dam impoundments.

The 2015 updates to the SWAP aquatic datasets provide several advantages in both the assessment of habitat priorities and the understanding of problems affecting these habitats. The grain size of the catchment areas around stream segments are much smaller and more refined than the HUC12 grain size, and the catchments and segments can be aggregated and disaggregated at different watershed spatial scales as needed. The catchment and stream segment connections also allow for assessments of land use and land cover conditions known to be related to stream health and overall habitat integrity. Finally, the upstream and downstream hydrologic connections provide a general means of understanding the linkages between upstream land and water uses on downstream sections of streams and rivers.

3.2.5. 2015 Updates to Species Distribution Footprints

The 2005 SWAP model used the individual species occurrence observation points as the basis for mapping the potential occupancy footprint of a species at a given location. For terrestrial species in 2005, occurrences inside one NatureServe "suitable habitat separation distance" (Box 4) were combined into one observation. For aquatic species, any occurrences of a

Table 6. Comparison of 2005 and 2015 mapping units

General Habitat Category	2005 Base Mapping Unit	2015 Base Mapping Unit
Terrestrial	TIGER-roadless blocks	100-acre hexagons, aggregated to 700-acre rosettes
Aquatic	12-digit Hydrologic Unit Code (HUC) watersheds	National Hydrography Dataset Plus, Version 2 catchments
Subterranean	Tiger-roadless blocks	100-acre hexagons, aggregated to 700-acre rosettes

Box 4. Separation Distance for Suitable Habitat

Distance (in kilometers) of intervening suitable habitat not known to be occupied that is great enough to effectively separate occurrences by limiting movement or dispersal of individuals between them. Suitable habitat is habitat capable of supporting reproduction or used regularly for feeding or other essential life history functions; a habitat in which you would expect to find the species (assuming appropriate season and conditions). For most animal species, the recommended minimum separation distance for intervening suitable habitat is 2 km (1.2 mi). This is to ensure that occurrences are not separated by unreasonably small distances, which would lead to the identification of unnecessarily fragmented populations as potential targets for conservation planning or action. Note: The separation distances for animals are currently under review and subject to revision. (Definition from NatureServe)

species within a HUC12 watershed were combined to represent one observation. Subterranean species occurrences were linked to their known cave sites, and similar to aquatics, all occurrences were combined into one observation point for that species in that cave system (TWRA 2005).

The 2015 update also uses individual species occurrence observations as the beginning point for mapping occupancy. A few key modifications recognize the limitations inherent in using observations based on general field surveys designed primarily to document species presence only, without recording absence where a species might be expected to occur. In addition, the hexagon framework and NHDPlus v2 updated base mapping units allow for greater flexibility in examining potential species distributions than the roadless block and larger HUC12 watershed approach.

First, for terrestrial species, potential distribution footprints from every individual species observation point were modeled to the 700-acre rosettes using a formula which takes into consideration the age in years of the observation point and the distance of the point to each 700-acre rosette as a percentage of 4 times the NatureServe suitable habitat separation distance of the species, with maximum distance/viability score combinations selected for each species/rosette pair (Wisby and Palmer 2015).

For aquatic species, the NHDPlus v2 stream segments were linked with each individual species observation. Then, stream segments upstream and downstream of the observation point within 2 times the NatureServe suitable habitat separation distance (Box 4) and with similar mean annual flow volumes to the flows at the observation point were identified to capture the potential distribution footprint of the species in a given collection of stream segments. The planning team considered NID dam locations to be barriers in the footprint development and these were not crossed when mapping potential species occurrence extents (Wisby and Palmer 2015).

Finally, for subterranean species, the 2015 model assigns all observation records to the cave system from which they are documented, duplicate occurrence records are removed, and one unique species/cave system observation developed. Using the 100-acre hexagon units of analysis, the planning team identified areas around all cave system entrances as habitat influencing subterranean species based on their distance to cave systems with documented GCN species.

"Douglas Dam - Tennessee 001," on the French Broad River - TVA Web Team, Wikimedia Commons

For species known to occupy dry zones in caves, a maximum distance of 2.5km was used, and for bats and karst species known to occupy cave streams and pools, a maximum distance of 5km was used. These distances were utilized to capture a general footprint of the organic recharge zone of each cave (2.5km or 1.5 mi) and to reflect the higher mobility and potential hydrologic recharge zone of bats and cave-stream dependent species,

respectively (Wisby and Palmer 2015). Bat species are the only faunal group associated with cave systems for which the date of occurrence observation was considered in the scoring system for subterranean priorities (Wisby and Palmer 2015).

3.2.6. Mapping Terrestrial, Aquatic, and Subterranean Priority Habitats

The final steps in the generation of priority maps involved combining the GCN prioritization scores with the species distribution footprints using the appropriate mapping unit framework – hexagons for subterranean and terrestrial, NHDPlus v2 stream segments for aquatics (for detailed scoring formulas, see Wisby and Palmer 2015). This mapping process allows for each major habitat category (terrestrial, aquatic, and subterranean) to be assessed using its individual scoring and footprint methodology, but also to combine the assessments into different types of visual map and tabular outputs for interpretation.

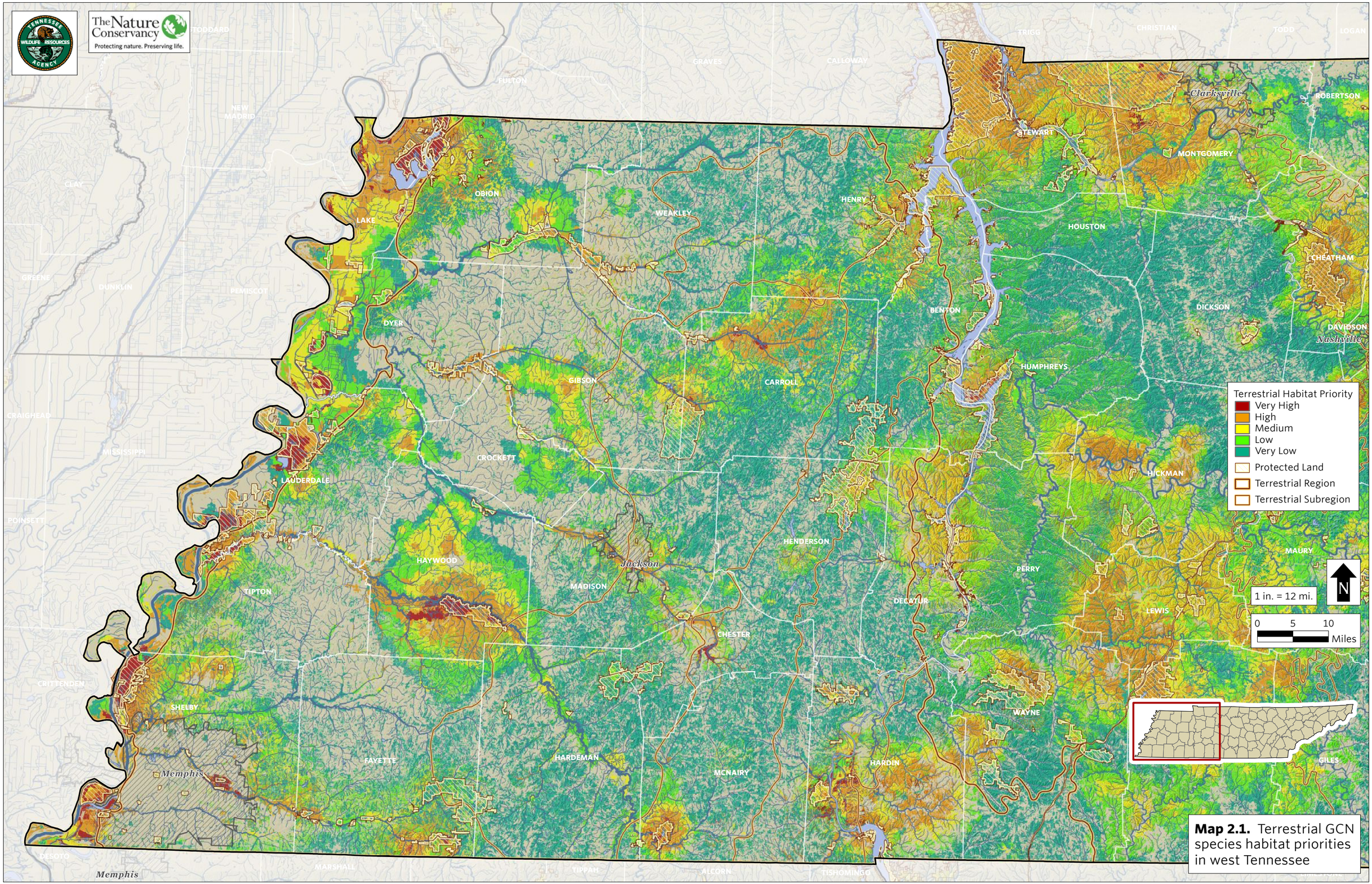
For terrestrial species, the planning team used the habitat preference scores for NatureServe ecological systems and the SEGAP landcover mapping of those systems in the final mapping process. They overlaid the SEGAP ecological system coverage with the 700-acre rosettes statewide, resulting in a GIS layer with roughly 400,000 ecological system class/rosette combinations. They then joined the terrestrial species distribution footprints (by 700-acre rosette) data table to the ecological system class/ rosette table. Final priority scores for ecological systems (habitats) within each rosette were calculated by summing the GCN species prioritization, observation age and distance, and habitat preference scores for all species within the rosette (Wisby and Palmer 2015).

A similar calculation process was performed to generate aquatic habitat priority maps by summing the GCN prioritization, observation age, and distribution footprint of every species for each stream segment. The planning team identified cave system priorities based on the GCN species global rarity and karst affinity score, with scores for known bat caves and areas within a 2.5 km radius receiving an additional score component based on the age of the observation record (Wisby and Palmer 2015).

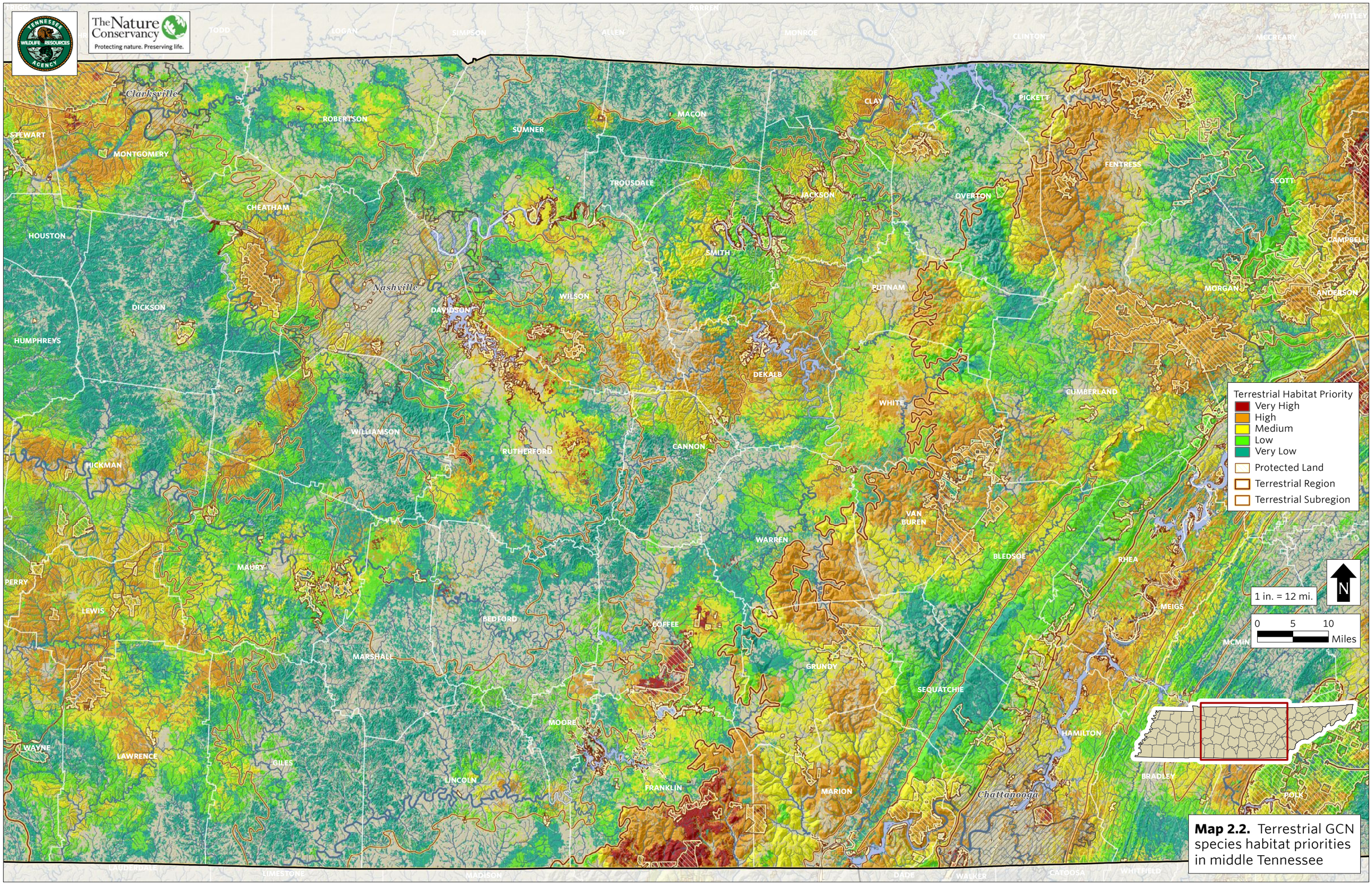
The 2005 plan used a scaled system categorizing the final habitat priority scores into low, medium, high, and very high for each major habitat, with the categorization performed independently for each terrestrial ecoregion, aquatic region, and subterranean region respectively (TWRA 2005, p. 83). Because some regions of the state have higher concentrations of imperiled species, a single scoring standard for mapping habitat priorities would not capture all habitat priorities statewide. The 2015 update uses a similar low, medium, high, and very high categorization for the priority scores. The mapping approach again is stratified by terrestrial ecoregion, aquatic region, and subterranean regions to capture representation of all GCN species and their priority habitats statewide.

3.2.7. 2015 Statewide Habitat Priority Maps

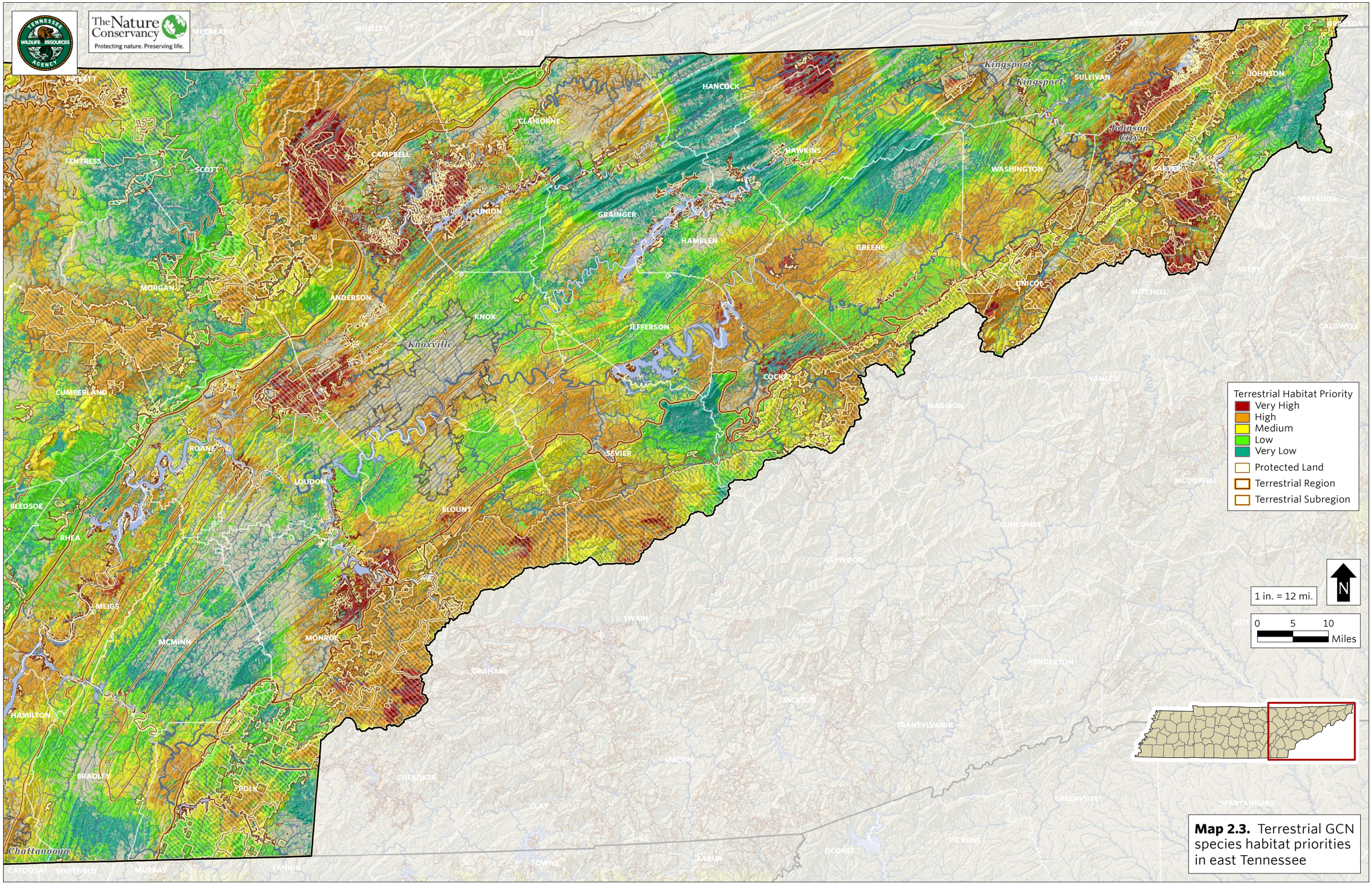
Maps of priority habitats for terrestrial, aquatic, and subterranean GCN species as well as all priority habitats combined follow.



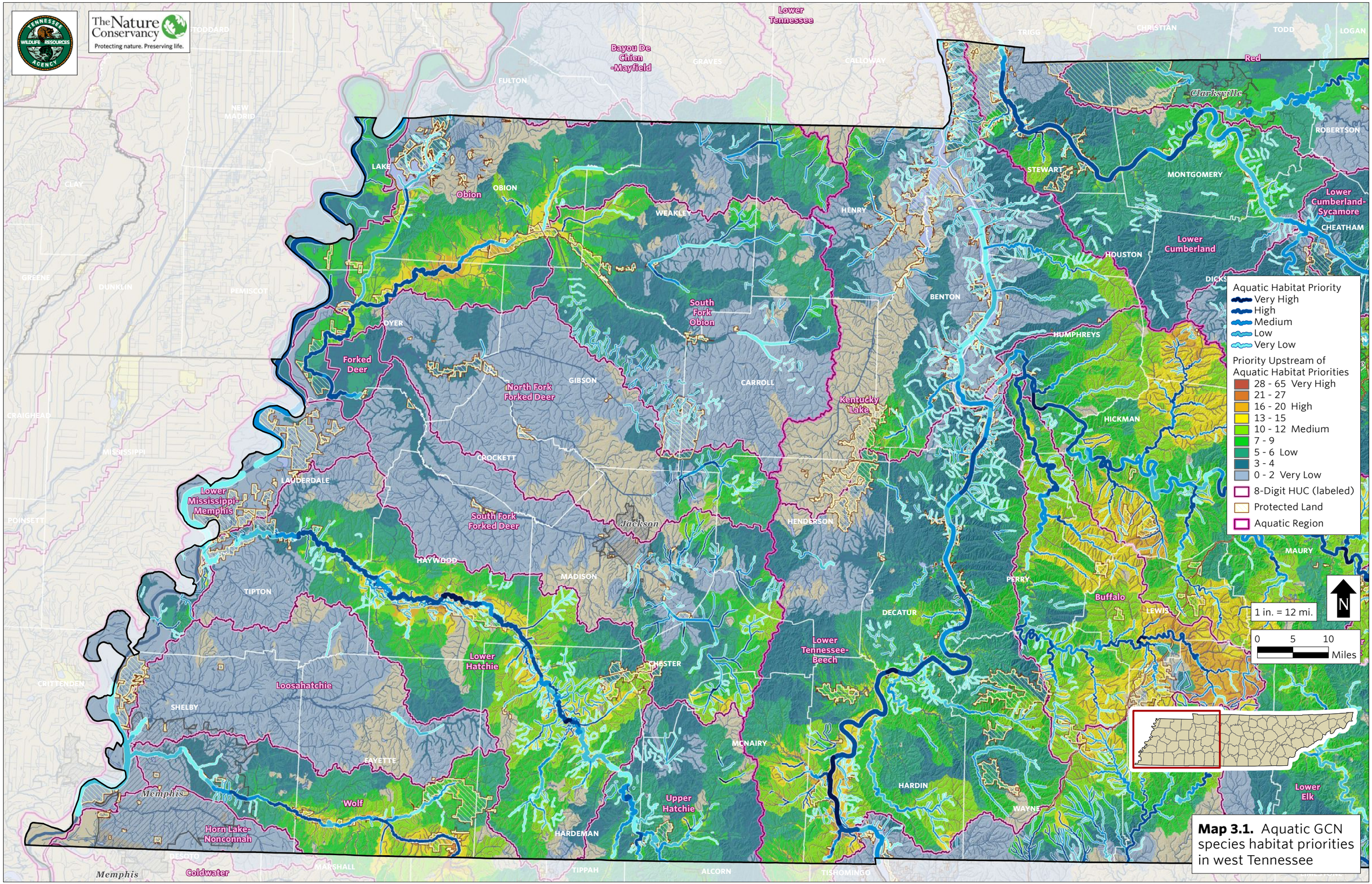
Map 2.1. Terrestrial GCN species habitat priorities in west Tennessee



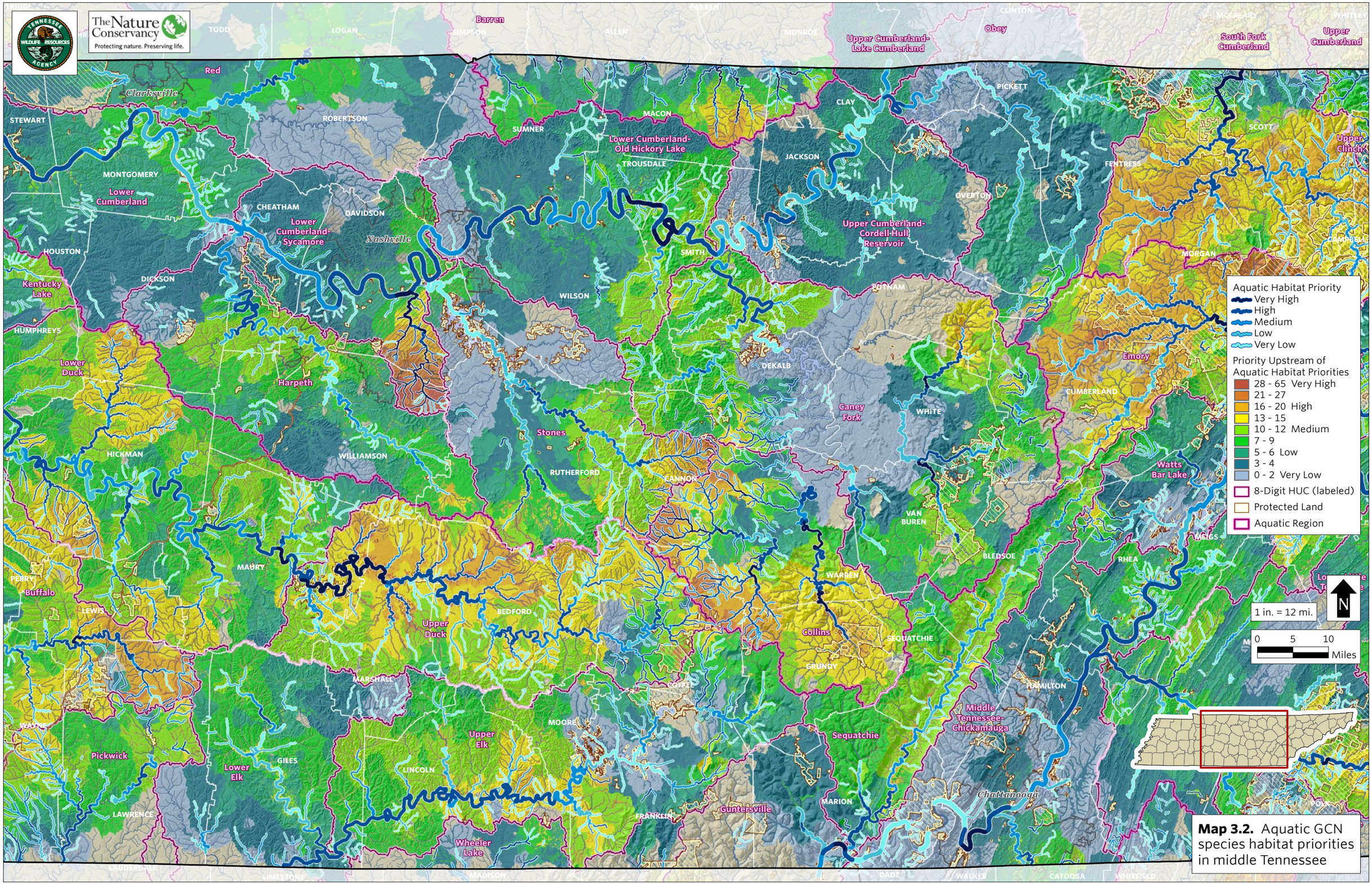
Map 2.2. Terrestrial GCN species habitat priorities in middle Tennessee



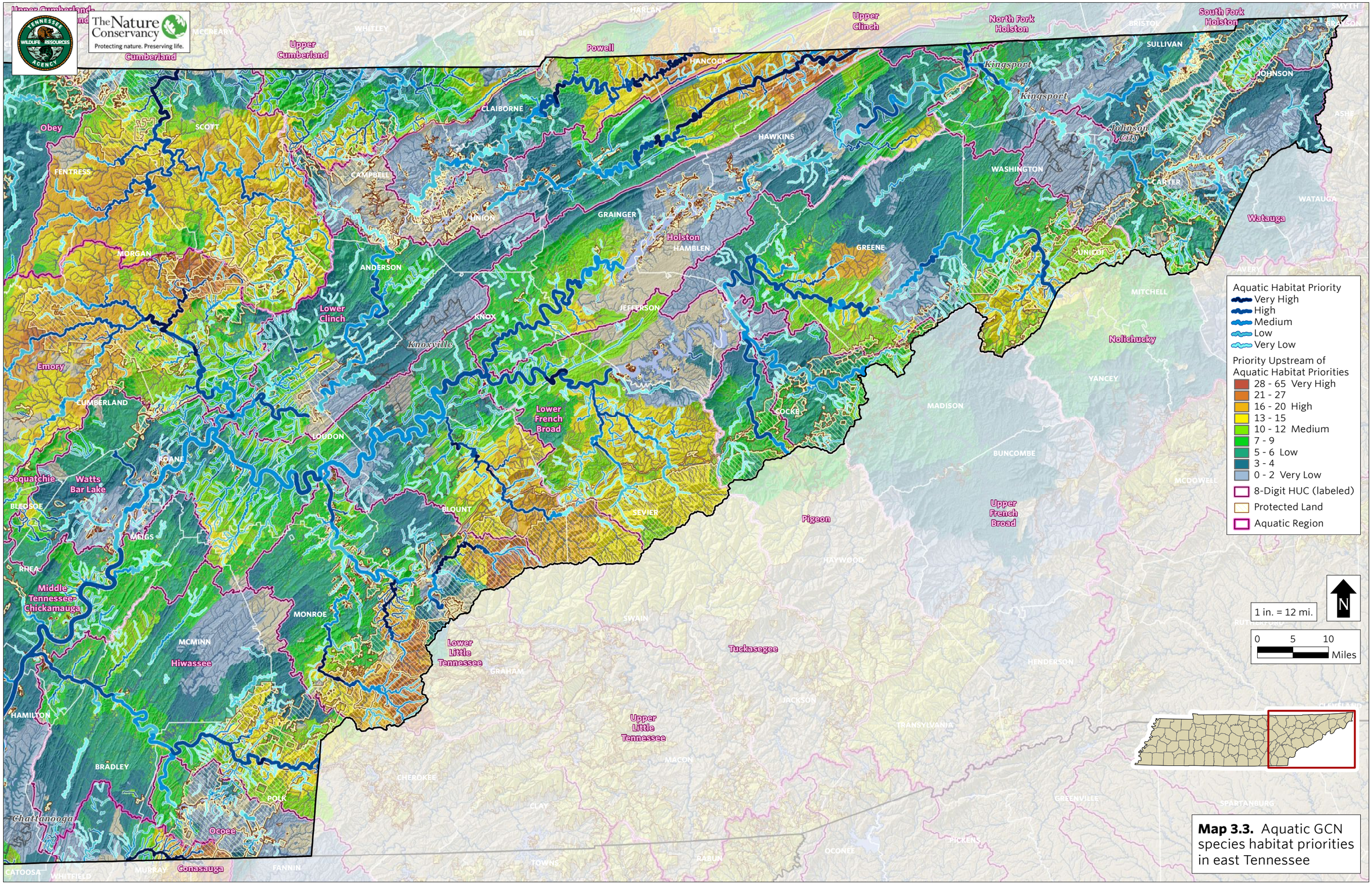
Map 2.3. Terrestrial GCN species habitat priorities in east Tennessee



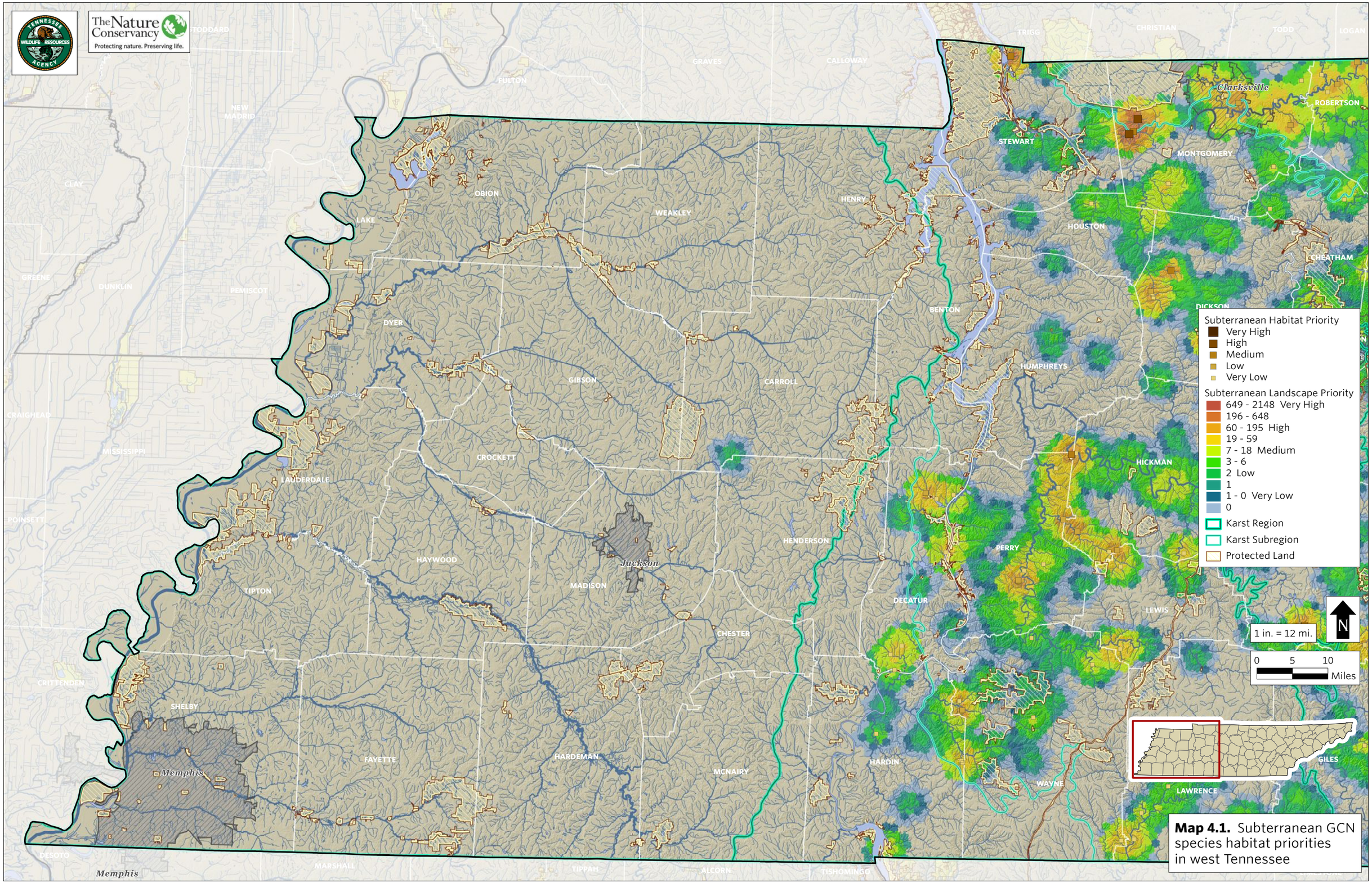
Map 3.1. Aquatic GCN species habitat priorities in west Tennessee



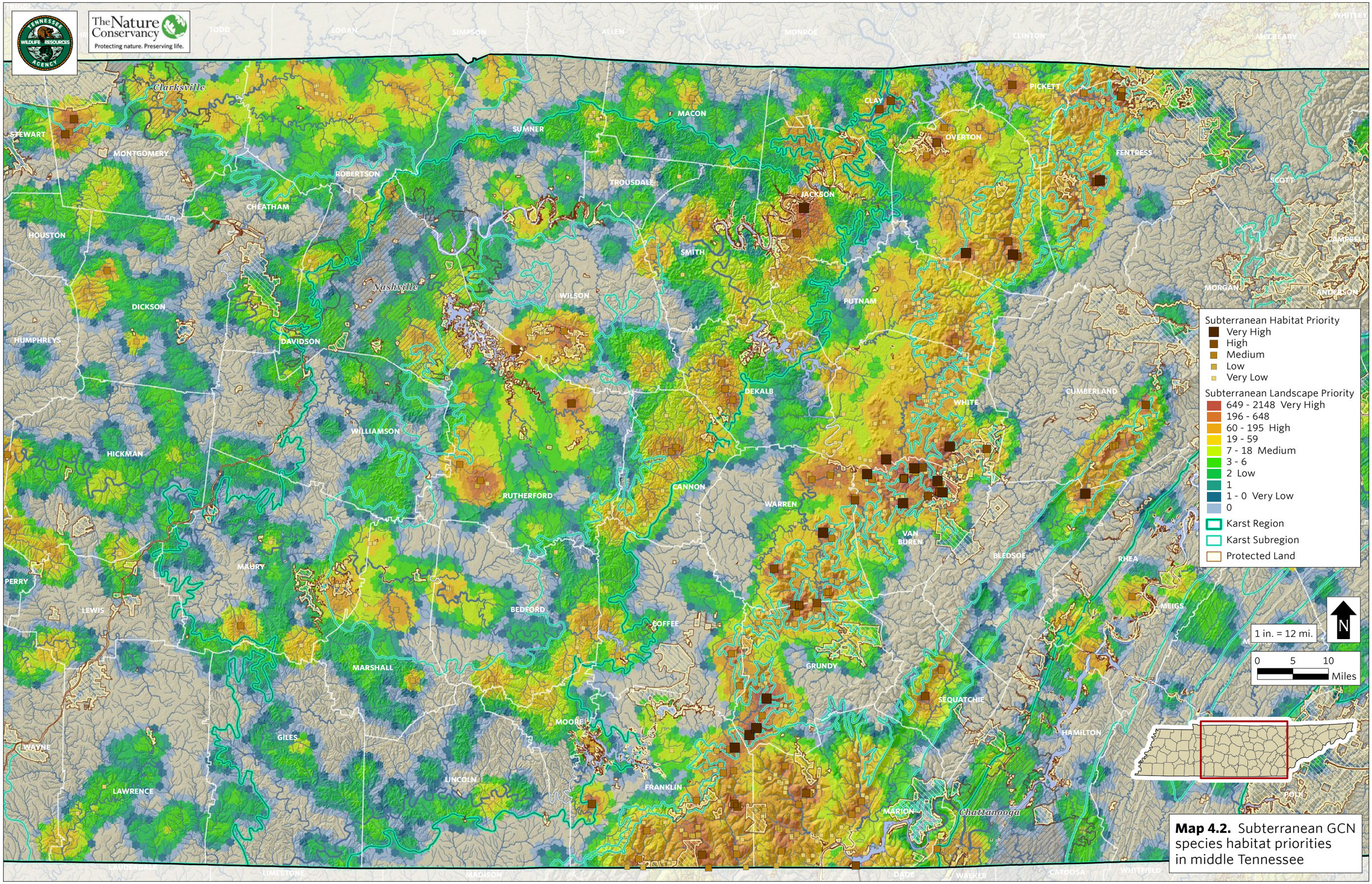
Map 3.2. Aquatic GCN species habitat priorities in middle Tennessee



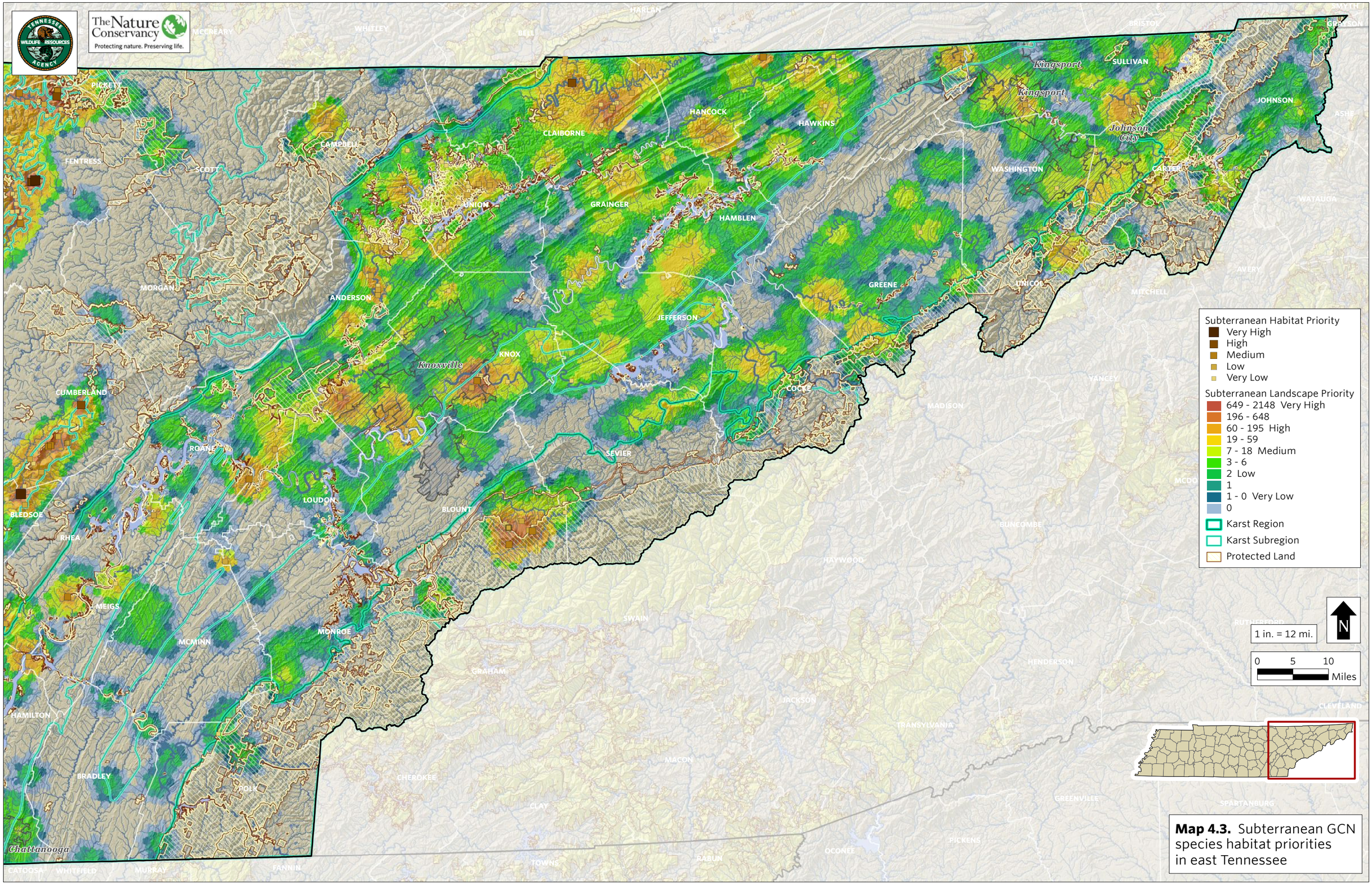
Map 3.3. Aquatic GCN species habitat priorities in east Tennessee



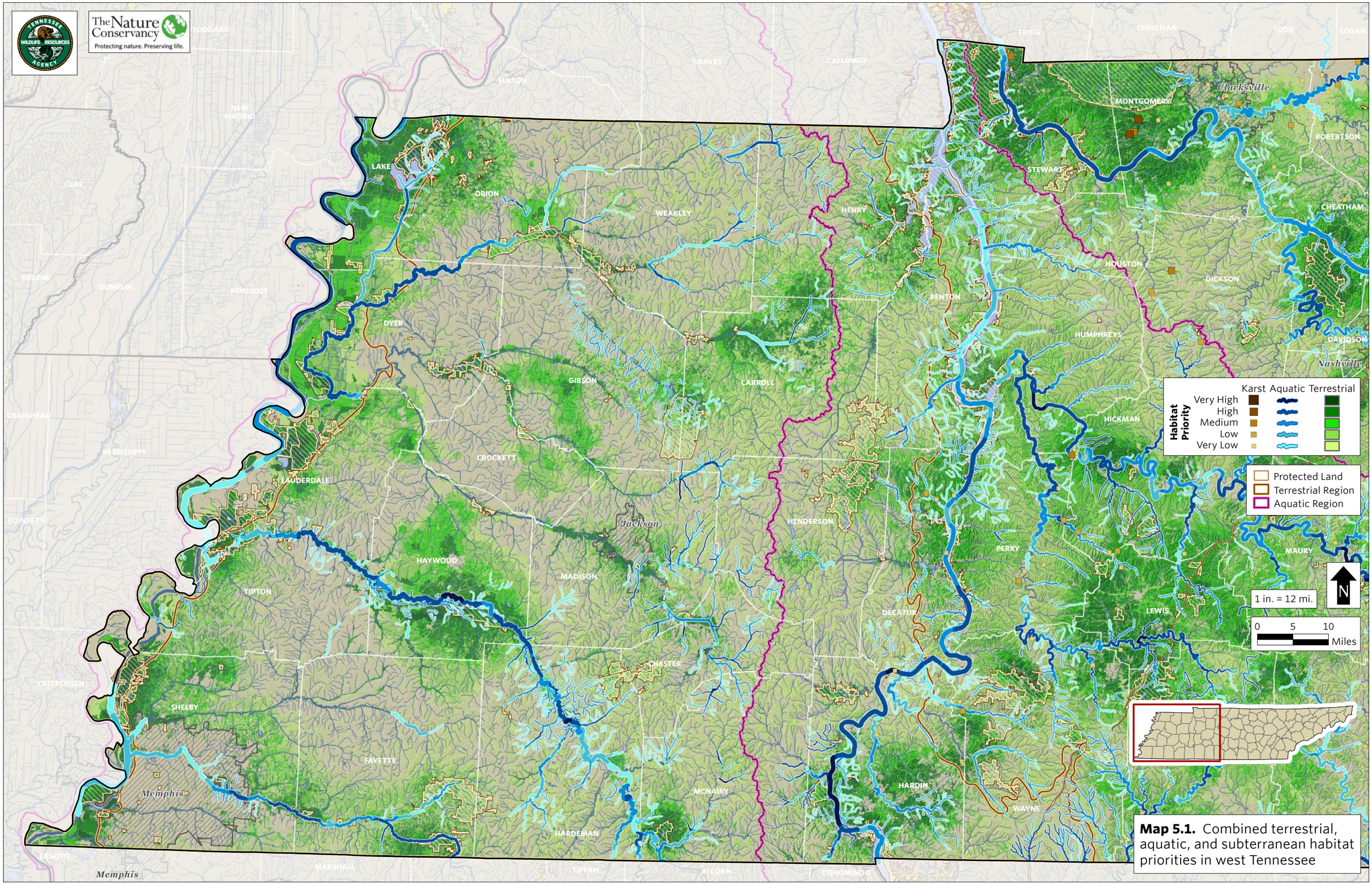
Map 4.1. Subterranean GCN species habitat priorities in west Tennessee



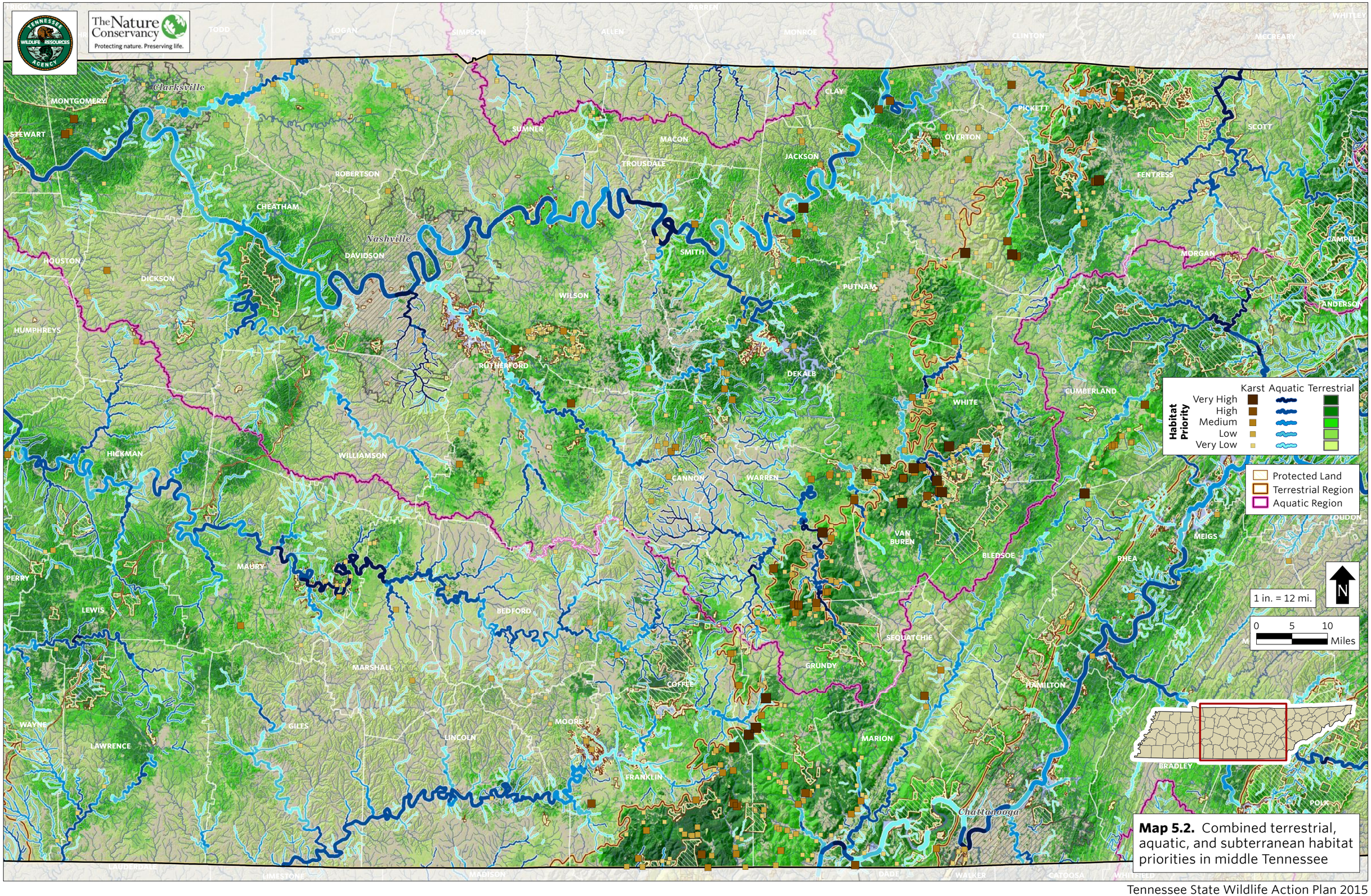
Map 4.2. Subterranean GCN species habitat priorities in middle Tennessee



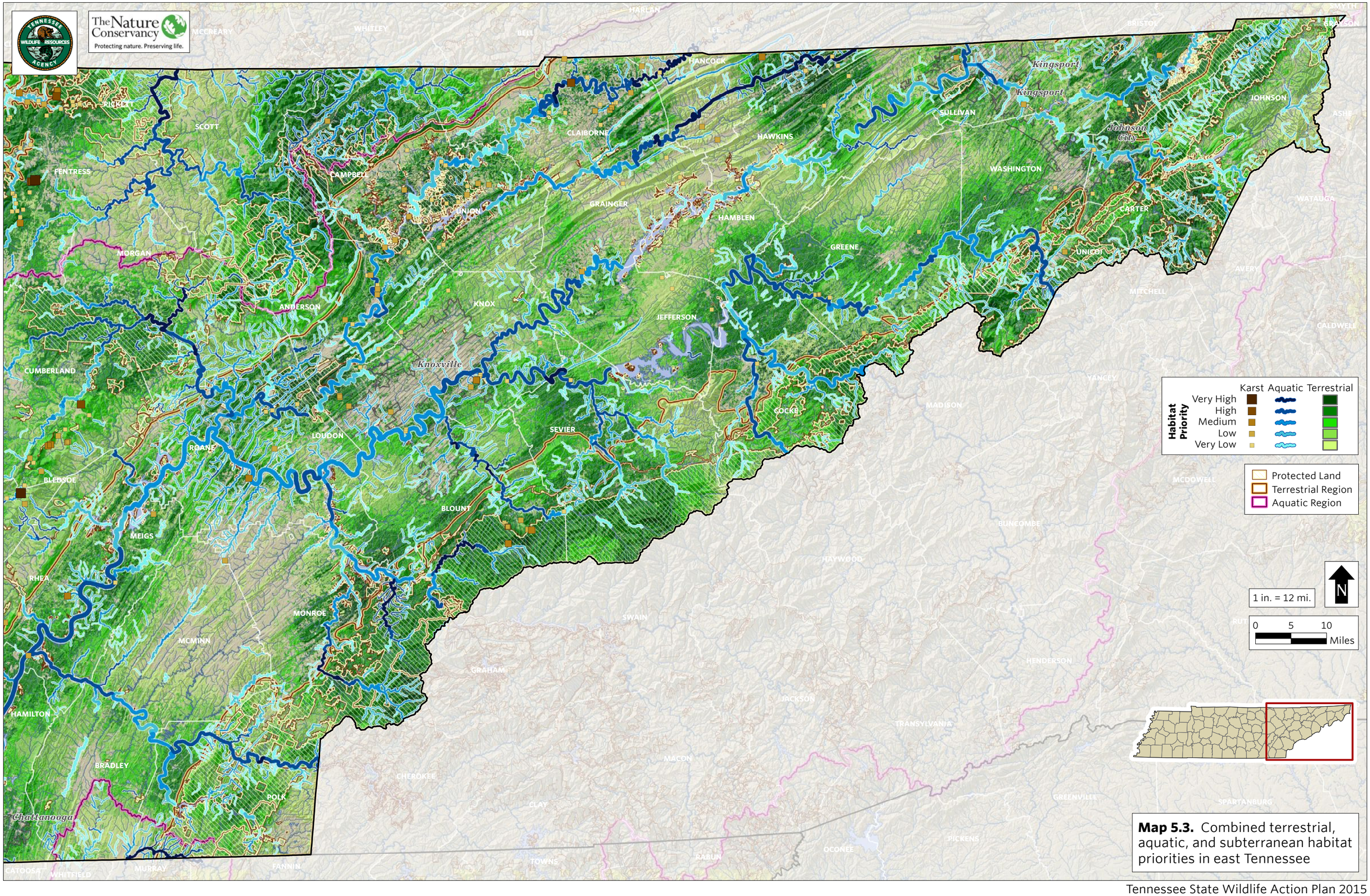
Map 4.3. Subterranean GCN species habitat priorities in east Tennessee



Map 5.1. Combined terrestrial, aquatic, and subterranean habitat priorities in west Tennessee



Map 5.2. Combined terrestrial, aquatic, and subterranean habitat priorities in middle Tennessee



Map 5.3. Combined terrestrial, aquatic, and subterranean habitat priorities in east Tennessee

3.2.8. Statewide Priority Habitat Summaries

Tables 7 through 12 summarize information on the priority terrestrial natural and semi-natural habitats by ecoregion. The data in these tables are ordered according to the average GCN species priority score for that habitat, with the scoring stratified down to the subregion scale. In certain instances, semi-natural habitats show higher priority scores than natural habitats in an ecoregion. This is due to the typically larger distribution footprint of species that can utilize semi-natural habitats (e.g. birds) and the fact that some natural habitats (e.g. cliffs or rockhouses) are very small in overall acreage, limiting the potential number of species that occupy them overall. In the Upper Gulf Coastal Plain and Mississippi River Alluvial Plain, bottomland and riparian forest habitats are most significant, and large acreages of upland forest types also occur in the Upper Gulf Coastal Plain. In the Interior Low Plateau (ILP), floodplain and riparian forests are again significant, as are both mesophytic and dry-mesic forests. The data for the ILP also demonstrate the significance of prairie, woodland/barren, and limestone glade habitats for a variety of rare GCN species. Prairie, woodland and limestone glade habitats can be smaller and more isolated in terms of their overall acreages in the ecoregion; however, they are home to many distinct plant and animal species. Forest habitat types also rank highest in priority within the Cumberland Plateau and Mountains and the Ridge and Valley ecoregions, although the specific forest system type shifts according to the ecoregion. In the Southern Blue Ridge, the dominant forest system, Southern Appalachian oak forest, ranks highly, as does a variety of other systems distributed in cove and high elevation settings in the ecoregion.

Table 13 summarizes the number of stream miles of highly-ranked habitat within each aquatic subregion across Tennessee. While the total amounts of the Conasauga and Barren River subregion watersheds within Tennessee are small in comparison to others, a good percentage of their stream miles in the state are ranked as high priority GCN habitat. The Cumberland, Tennessee, and Coastal Plain-Mississippi aquatic regions have an average of approximately 15%, 12% and 6% of their total stream miles within the state of Tennessee ranked as medium, high, or very high priority habitat.

Fall in the Blue Ridge of Tennessee - Bill Showalter

Table 7. Summary of priority terrestrial habitats in the Mississippi River Alluvial Plain

Mississippi River Alluvial Plain terrestrial habitats	Average GCN species priority score for habitat, stratified down to subregion	Total acres of very high-, high-, and medium-ranked habitat
Natural habitats		
Mississippi River Bottomland Depression	70.0	97
Mississippi River Low Floodplain (Bottomland) Forest	50.4	115,288
Mississippi River Riparian Forest	46.3	27,846
Semi-natural habitats		
Old Field / Successional	32.6	6,378
Pasture	28.0	225
Cropland	15.8	117,227

Table 8. Summary of priority terrestrial habitats in the Upper Gulf Coastal Plain

Upper Gulf Coastal Plain terrestrial habitats	Average GCN species priority score for habitat, stratified down to subregion	Total acres of very high-, high-, and medium-ranked habitat
Natural habitats		
East Gulf Coastal Plain Large River Floodplain Forest	27.0	86,989
South-Central Interior Mesophytic Forest	25.8	1,308
East Gulf Coastal Plain Small Stream and River Floodplain Forest	23.5	224,138
South-Central Interior Small Stream and Riparian	23.4	5,086
East Gulf Coastal Plain Northern Loess Bluff Forest	17.5	20,764
East Gulf Coastal Plain Northern Mesic Hardwood Slope Forest	7.8	85,670
East Gulf Coastal Plain Interior Shortleaf Pine-Oak Forest	6.9	23,010
South-Central Interior / Upper Coastal Plain Flatwoods	5.2	5,017
East Gulf Coastal Plain Northern Dry Upland Hardwood Forest	4.3	55,639
East Gulf Coastal Plain Northern Loess Plain Oak-Hickory Upland	3.4	13,046
East Gulf Coastal Plain Limestone Forest	1.6	5
Semi-natural habitats		
Old Field / Successional	11.3	100,017
Pasture	9.1	149,288
Cropland	5.7	252,860

Table 9. Summary of priority terrestrial habitats in the Interior Low Plateau

Interior Low Plateau terrestrial habitats	Average GCN species priority score for habitat, stratified down to subregion	Total acres of very high-, high-, and medium-ranked habitat
Natural habitats		
South-Central Interior Large Floodplain	39.0	28,293
Eastern Highland Rim Prairie and Barrens	28.7	61,511
South-Central Interior Small Stream and Riparian	25.5	39,352
Nashville Basin Limestone Glade and Woodland	23.8	86,410
South-Central Interior Mesophytic Forest	21.5	943,809
Southern Appalachian Low-Elevation Pine Forest	17.3	3,354
Southern Interior Low Plateau Dry-Mesic Oak Forest	13.7	1,015,574
Central Interior Calcareous Cliff and Talus	3.8	280
Central Interior Acidic Cliff and Talus	2.2	12
Semi-natural habitats		
Old Field / Successional	11.6	101,453
Cropland	7.4	105,393
Pasture	6.5	293,987
Forest Plantation	1.3	4,749

Table 10. Summary of priority terrestrial habitats in the Cumberland Plateau and Mountains

Cumberland Plateau & Mountains terrestrial habitats	Average GCN species priority score for habitat, stratified down to subregion	Total acres of VH, H, & M ranked habitat
Natural habitats		
South-Central Interior Large Floodplain	36.5	573
Southern and Central Appalachian Cove Forest	33.5	58,967
Southern Appalachian Montane Pine Forest and Woodland	29.4	5,383
Allegheny-Cumberland Dry Oak Forest and Woodland	27.9	619,308
Southern Ridge and Valley / Cumberland Dry Calcareous Forest	27.6	627,596
South-Central Interior Mesophytic Forest	27.2	322,982
Appalachian (Hemlock)-Northern Hardwood Forest	25.7	119,785
South-Central Interior Small Stream and Riparian	23.4	21,038
Southern Appalachian Low-Elevation Pine Forest	21.4	92,045
Cumberland Acidic Cliff and Rockhouse	15.7	1,812
Cumberland Riverscour	8.8	161
Semi-natural habitats		
Old Field / Successional	9.5	50,761
Pasture	8.0	34,468
Cropland	7.3	5,999
Forest Plantation	1.7	1,835

Table 11. Summary of priority terrestrial habitats in the Ridge and Valley

Ridge and Valley terrestrial habitats	Average GCN species priority score for habitat, stratified down to subregion	Total acres of VH, H, & M ranked habitat
Natural habitats		
South-Central Interior Large Floodplain	47.5	9,197
Southern Appalachian Oak Forest	47.4	2,748
Southern and Central Appalachian Cove Forest	37.5	5,625
South-Central Interior Mesophytic Forest	31.4	282,972
South-Central Interior Small Stream and Riparian	31.1	53,871
Southern Ridge and Valley / Cumberland Dry Calcareous Forest	29.2	746,861
Southern Interior Calcareous Cliff	29.0	5
Southern Appalachian Montane Cliff and Talus	27.7	36
Appalachian (Hemlock)-Northern Hardwood Forest	27.0	12,586
Southern Appalachian Low-Elevation Pine Forest	26.8	118,418
Allegheny-Cumberland Dry Oak Forest and Woodland	25.0	212,067
Southern Appalachian Montane Pine Forest and Woodland	18.0	932
Cumberland Acidic Cliff and Rockhouse	7.1	91
Semi-natural habitats		
Old Field / Successional	16.4	156,524
Pasture	15.9	482,969
Cropland	15.5	49,416
Forest Plantation	0.4	64

Table 12. Summary of priority terrestrial habitats in the Southern Blue Ridge

Southern Blue Ridge terrestrial habitats	Average GCN species priority score for habitat, stratified down to subregion	Total acres of VH, H, & M ranked habitat
Natural habitat		
Southern Appalachian Northern Hardwood Forest	40.4	12,956
Central and Southern Appalachian Spruce-Fir Forest	39.9	5,775
Southern and Central Appalachian Cove Forest	34.4	124,142
Appalachian (Hemlock)-Northern Hardwood Forest	30.6	68,148
Southern Appalachian Oak Forest	30.4	719,556
Southern Appalachian Rocky Summit	26.0	165
South-Central Interior Small Stream and Riparian	25.0	14,012
Southern Appalachian Montane Pine Forest and Woodland	24.6	10,183
Southern Appalachian Low-Elevation Pine Forest	23.5	100,503
South-Central Interior Large Floodplain	20.5	444
Southern Appalachian Montane Cliff and Talus	18.2	340
Southern Appalachian Grass and Shrub Bald	9.5	462
Southern and Central Appalachian Bog and Fen*	2.6	12*
Semi-natural habitat		
Old Field / Successional	10.1	2,725
Pasture	5.9	687

*Acreage for Southern Central and Appalachian Bog and Fen habitat includes total across all ranks.

Table 13. Summary of priority aquatic habitats, summarized by aquatic subregion

Aquatic Subregion	Linear stream miles in subregion	Total stream miles of very high-, high-, and medium-ranked habitat	% of linear stream miles ranked very high, high, and medium
Barren River	588	111	19
Coastal Plain, Mississippi River	14,886	875	6
Conasauga River	234	63	27
Cumberland River, Cumberland Mountain	1,844	455	25
Cumberland River, Lower Cumberland	4,433	381	9
Cumberland River, Nashville Basin	2,397	253	11
Cumberland River, Upper Cumberland	5,205	720	14
Tennessee River, Blue Ridge	8,276	762	9
Tennessee River, Cumberland Plateau	4,491	499	11
Tennessee River, Lower Tennessee	11,045	1240	11
Tennessee River, Nashville Basin	4,679	671	14
Tennessee River, Ridge and Valley	6,808	1055	15